U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-261 330

Radioactivity Standards Distribution Program FY 1977

Environmental Monitoring and Support Lab, Las Vegas, Nev

Oct 76

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
EPA-600/4-76-053		

4. TITLE AND SUBTITLE	5. REPORT DATE
RADIOACTIVITY STANDARDS DISTRIBUTION PROGRAM FY 1977	October 1976
	6. PERFORMING ORGANIZATION CODE

7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT NO.
Lee H. Ziegler, Quality Assurance Branch Monitoring Systems Research and Development Division	

9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. PROGRAM ELEMENT NO.
Environmental Monitoring and Support Laboratory Office of Research and Development U.S. Environmental Protection Agency Las Vegas, Nevada 89114	1HD621
	11. CONTRACT/GRANT NO.

12. SPONSORING AGENCY NAME AND ADDRESS	13. TYPE OF REPORT AND PERIOD COVERED
Same as above	interim (FY 1977)
	14. SPONSORING AGENCY CODE EPA-ORD, Office of Monitoring and Technical Support

15. SUPPLEMENTARY NOTES

16. ABSTRACT

A program for the distribution of calibrated radioactive samples, as one function of EPA's quality assurance program for environmental radiation measurements, is described. Included is a discussion of the objectives of the distribution program and a description of the preparation, availability, and distribution of calibrated radioactive samples. Instructions and application forms are included for laboratories desiring to participate in the program.

This document is not a research report. It is designed for use by personnel of laboratories participating or desiring to participate in the Radioactivity Standards Distribution Program which is a part of the U.S. Environmental Protection Agency's quality assurance program.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
quality assurance quality control radioactivity quantitative analysis calibrating standards		07 B 14 B, D 18 H

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)*	21. NO OF PAGES
RELEASE TO PUBLIC	UNCLASSIFIED	18
	20. SECURITY CLASS *(This page)*	22. PRICE
	UNCLASSIFIED	3.50 - 3.00

EPA Form 2220-1 (9-73)

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EPA-600/4-76-053
October 1976

RADIOACTIVITY STANDARDS DISTRIBUTION PROGRAM
FY 1977

by

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357110

PB 261 330

EPA-600/4-76-053
October 1976

Environmental Monitoring Series

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NATIONAL TECHNICAL
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U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

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PREFACE

Quality assurance is an integral part of any viable environmental monitoring activity. The primary goals of the U.S. Environmental Protection Agency's (EPA) quality assurance program are to improve and document the credibility of environmental measurements. To achieve these goals, quality assurance is needed in nearly all segments of monitoring activities and should cover personnel, methods selection, equipment, and data handling procedures.

Five major functions, each essential to an effective quality assurance effort, comprise EPA's quality assurance program.

- Promulgation of standardized methods of measurement
- Distribution of standard reference materials
- Issuance of guidelines and procedures
- Training and technical assistance
- Evaluation and certification of monitoring activities

This manual has been prepared to assist laboratories involved with environmental radiation measurements in developing and maintaining a quality control program and documenting the precision and accuracy of their data. All EPA monitoring programs are requested to make use of this document in planning their own radiation measurements and in assisting the States in carrying out radiation monitoring activities.

Comments concerning the utility of this document, along with any suggestions for possible changes and revisions, are welcomed. Questions on matters related to quality assurance of environmental measurements in various fields should be directed to the following person(s):

Air Pollution

Mr. Thomas Clark
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Environmental Monitoring and Support Laboratory
Research Triangle Park, North Carolina 27711

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Analytical Chemistry Branch
Environmental Toxicology Division
Health Effects Research Laboratory
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Environmental Monitoring and Support Laboratory
Las Vegas, Nevada 89114

Water

Mr. John Winter, Chief
Quality Assurance Branch
Environmental Monitoring and Support Laboratory
Cincinnati, Ohio 45268

Periodically, manuals and documents will be issued which provide guidelines to be followed in all phases of monitoring activities. Use of these guidelines throughout the Agency will enable a uniform approach to be established within EPA which ultimately can be implemented at the State level. This should permit a significant improvement in the validity and reliability of environmental data collected throughout the Nation.

The implementation of a total and meaningful national environmental quality assurance effort cannot succeed without the full support of all monitoring programs. Your cooperation is appreciated.

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PROGRAM OBJECTIVES

Environmental measurements are made daily by many different Federal, State, local and private agencies. The data from these measurements are used for a wide variety of purposes including assessment of health effects, establishment of standards and guides, and for enforcement activities. It is therefore imperative that the precision and accuracy of the data be assured in order that policy decisions concerning environmental quality be based on valid and comparable data.

The quality assurance program of the U.S. Environmental Protection Agency (EPA) is designed to encourage the development and implementation of quality control procedures at all levels of sample collection, analysis, data handling, and reporting. Quality control responsibilities, in the radiation area, have been assigned to the Quality Assurance Branch at the EPA's Environmental Monitoring and Support Laboratory in Las Vegas. This Branch, as an integral part of its overall quality assurance effort, prepares and distributes a variety of calibrated low-level radioactive samples for use in the laboratories of Federal, State, and local agencies.

The major objective of this program is to encourage the development of intralaboratory and interlaboratory quality control procedures and thus ensure that environmental radiation data are valid. Providing accurately calibrated samples assists laboratories in calibrating new instruments, implementing and maintaining routine instrument calibration programs, evaluating analytical procedures, and developing and revising data processing programs.

The following pages briefly describe standard preparation procedures, list the radionuclides available, and indicate how a laboratory may request standards.

If your laboratory does not currently make use of the services provided by the Quality Assurance Branch at the EMSL-LV, it is encouraged to do so.

PREPARATION AND CALIBRATION OF SAMPLES

The radionuclides used in preparing calibrated samples are obtained from the National Bureau of Standards, the Laboratorie de Metrologie des Rayonnements Ionisants (France), Amersham/Searle, or from other reliable commercial sources. The uncertainty in the known activity of individual sources ranges from 0.5 to 5 percent. Activity of radionuclide impurities, excluding daughters, is documented and typically is less than 1 percent of the activity of the principal radionuclide at the time of sample preparation.

Upon receipt, a radionuclide is checked for its activity and for the presence of radioactive contaminants. The sample is then diluted to the desired activity level (500-6,600,000 dpm/gm) with a carrier of the same chemical composition and concentration as used by the supplier. In certain cases the addition of a stabilizer is required. The accuracy of the dilution is carefully checked and the solution flame sealed in 5-ml ampuls.

Accompanying each calibrated sample is a certificate listing pertinent information concerning the sample and its calibration including an estimate of the errors associated with the value of the activity (Figure 1). For gamma emitters, a net plot of the pulse height spectrum is also included (Figure 2).

To further assure the precision and accuracy of the calibrated samples, the Quality Assurance Branch participates in on-going intercomparison studies with the National Bureau of Standards (NBS). These studies involve the measurement of unknown samples supplied by the NBS, and the measurement by NBS of EPA-prepared samples. Results of this program are shown in Figure 3. More complete details of the intercomparison studies with the NBS are described elsewhere.*

AVAILABILITY OF CALIBRATED SAMPLES

The Quality Assurance Branch recommends use of the half lives listed in this document. The primary sources of these half lives are "Nuclear Decay Data for Selected Radionuclides," edited by M. J. Martin (ORNL-5114, VC - 34c - Nuclear Physics, Oak Ridge National Laboratory) and Nuclear Data Tables, Volume A8, Numbers 1,2, edited by Katherine Way. Half lives of those radionuclides not listed in either of these publications were taken from selected volumes of the Nuclear Data Sheets, edited by the Nuclear Data Group.

AQUEOUS CALIBRATED SAMPLES

The inventory of calibrated samples at the beginning of Fiscal Year 1977 consists of some 30 calibrated radionuclide solutions. Every effort is made to keep this inventory supplied for immediate delivery with the exception of iodine-131 and barium-140. Iodine-131 is prepared bimonthly and distributed to requestors of record. Barium-140 is prepared approximately every 4 months and supplied to requestors of record. While the types of calibrated samples in the inventory vary during the year, every effort will be made to keep the following calibrated solution samples in stock and available for distribution at any time.

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* Quality Assurance Branch, Radiation Quality Assurance Intercomparison Studies 1974-1975, Environmental Monitoring and Support Laboratory, EPA-600/4-75-014, October 1975, Las Vegas, Nevada.

U S ENVIRONMENTAL PROTECTION AGENCY
ENVIRONMENTAL MONITORING AND SUPPORT LABORATORY-LAS VEGAS
QUALITY ASSURANCE BRANCH

Calibration Certificate

Description
Principal radionuclide _____ Half-life _____
Nominal activity _____ _____ curies
Nominal volume _____ ml in ampoule/bottle number _____

Supplied to
Request _____

Measurement
Activity of principal radionuclide
Activity per gram of this solution
_____ _____ curies of _____
at 0400 hours PST on _____

Activity of daughter radionuclide
The principal activity was accompanied at the quoted time by
_____ _____ curies per gram
of the daughter nuclide _____

TOTAL MASS OF THIS SOLUTION _____ grams

TOTAL PRINCIPAL ACTIVITY PER GRAM AT THE QUOTED TIME _____ _____ curies

Figure 1. Calibration certificate

Method of measurement

Useful Life

This radionuclide has decayed through [ ] half lives since it was obtained by EMSL-LV

We recommend that this solution should not be used after [ ]

Purity

The manufacturer states that activities other than that of the principal nuclide and of its daughter nuclides if any were estimated/known to be

(1)	less than equal to	%	of the principal activity
(2)	less than equal to	%	of the principal activity
(3)	less than equal to	%	of the principal activity

The activity of impurity (1) is not (2) is not (3) is not included in the quoted figures of the principal activity

It is estimated that we have added the following impurities

(1)	less than		curies/gram
(2)	less than		curies/gram
(3)	less than		curies/gram

Figure 1 (continued). Calibration certificate

Random Errors

The repeatability of this standardization (dilutions, source preparations, counting statistics, mass determinations, etc.) was such that the certified value of the radioactive concentration of the principle activity had a standard error (σ) not greater than

$\pm$ [ ] % (The 99.7% confidence limits are given by $\pm 3\sigma$)

The total systematic error (sum of estimated maximum residual systematic errors due to dispensing, counting losses, counting corrections, known uncertainty of standard) of the certified radioactive concentrations of the principle activity has been estimated not to exceed [+ % (δ)] or [- % (δ')]

The overall limits of error calculated on the basis of $+(3\sigma + \delta)$ or $-(3\sigma + \delta')$ are

[+ %] or [- %] of the quoted radioactive concentration

The effective standard deviation is defined as 1/6th of the range between the overall limits $+(3\sigma + \delta)$ and $-(3\sigma + \delta')$ and is therefore [ ] %

Decay Schemes This standardization is based on the following assumptions of the principle nuclide, its daughter nuclides and impurities (no allowance for error in these assumptions or the assumption of quoted half-life have been included in the statement of accuracy above)

Chemical Composition of Solution

Carrier content per gram of solution

Other components

Preservative

Remarks

Date Certificate Prepared _____

Approval Signature _____

Figure 1 (continued). Calibration certificate

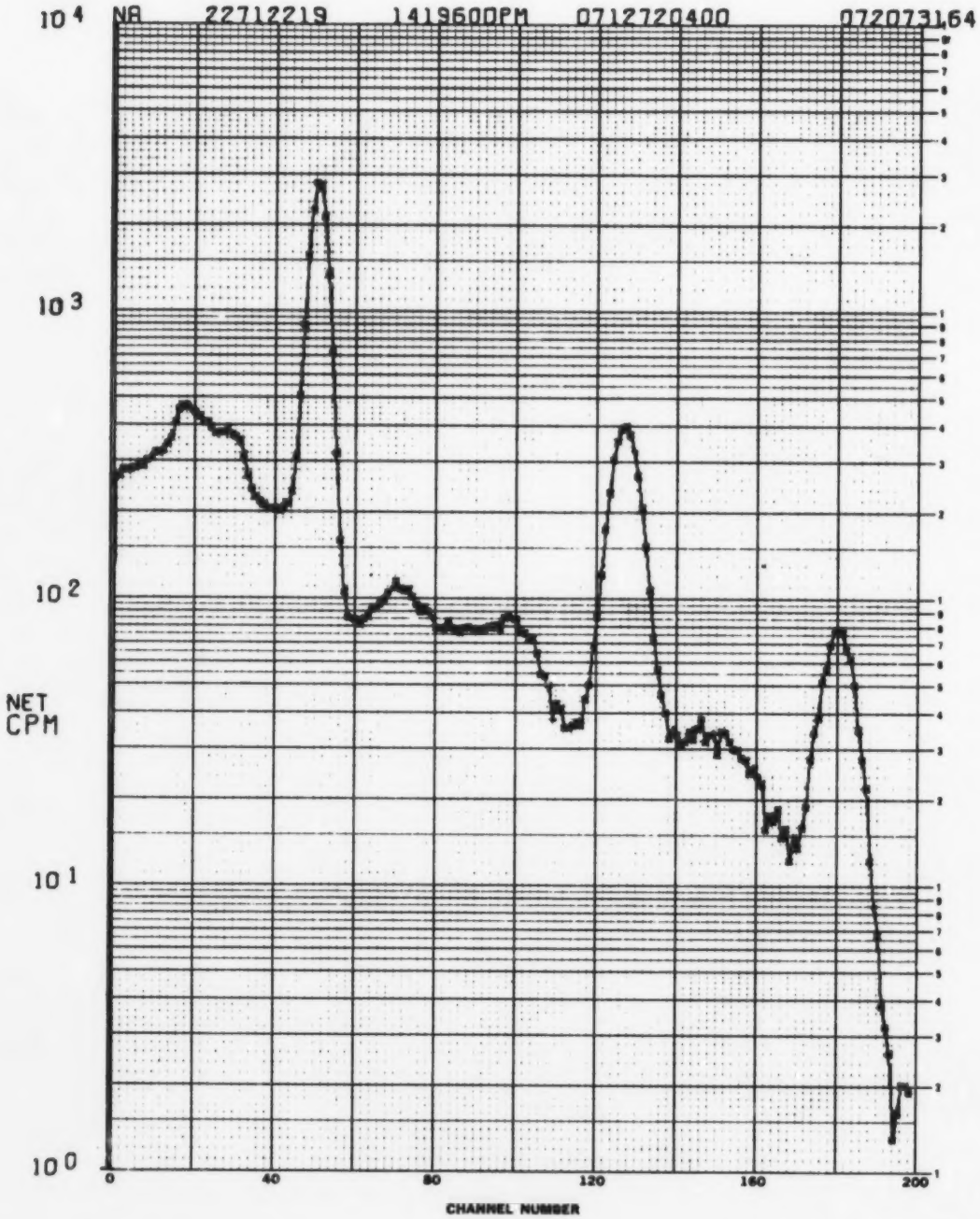

Figure 2. Net pulse height spectrum of sodium-22 measured with 4-inch × 4-inch NaI(Tl) crystal

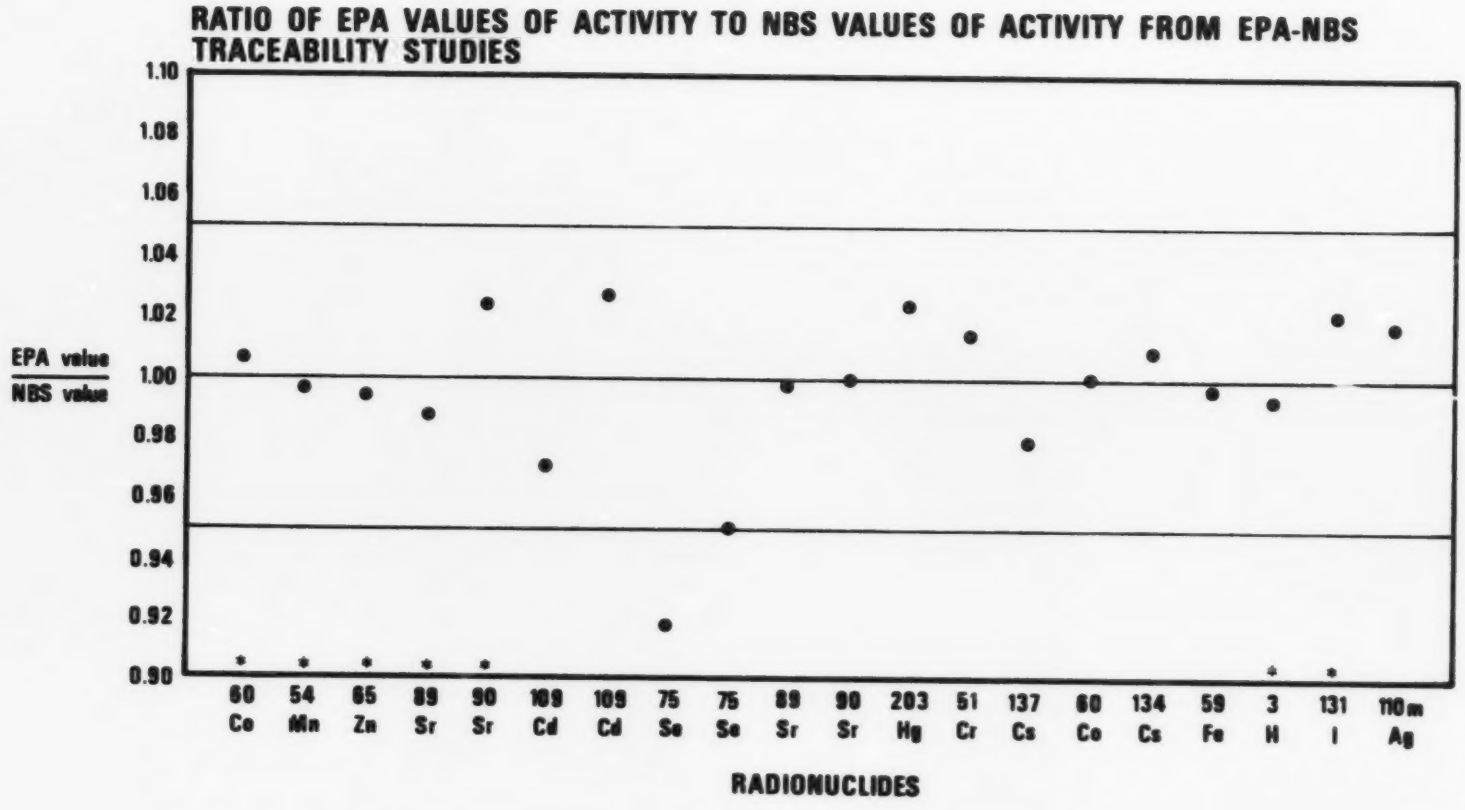

Figure 3. Ratio of EPA values of activity to NBS values of activity from EPA-NBS traceability studies

CALIBRATED RADIONUCLIDE SAMPLES KEPT IN INVENTORY

Isotope	Type Emission	Half-Life	Isotope	Type Emission	Half-Life
^{3}H	β^-	12.35 y	^{109}Cd	γ	453 d
^{14}C	β^-	5730 y	^{110m}Ag	β^-,γ	250.8 d
^{22}Na	β^+,γ	2.602 y	^{125}Sb	β^-,γ	2.77 y
^{46}Sc	β^-,γ	83.80 d	^{131}I	β^-,γ	8.04 d
^{54}Mn	γ	312.5 d	^{133}Ba	γ	10.5 y
^{57}Co	γ	270.9 d	^{134}Cs	β^-,γ	2.062 y
^{60}Co	β^-,γ	5.271 y	^{137}Cs	β^-,γ	30.0 y
^{65}Zn	β^+,γ	244.1 d	^{140}Ba	β^-,γ	12.8 d
^{75}Se	γ	120 d	^{144}Ce	β^-,γ	284 d
^{88}Y	β^+,γ	107 d	^{226}Ra	α,γ	1600 y
^{89}Sr	β^-	50.5 d	^{239}Pu	α	2.439×10^4 y
^{90}Sr	β^-	28.5 y	^{241}Am	α	433 y
^{106}Ru	β^-,γ	369 d			

Throughout the year other radionuclide solutions are calibrated and made available for distribution. In order to service the user efficiently, the Quality Assurance Branch will obtain, calibrate, and distribute the following radionuclides, as time and resources permit, after we have received 10 or more requests for them. The user is reminded, however, that these are prepared as time permits, and as the Branch is able to maintain the above inventory.

Isotope	Type Emission	Half-Life	Isotope	Type Emission	Half-Life
^{7}Be	γ	53.3 d	^{124}Sb	β^-,γ	60.20 d
^{51}Cr	γ	27.704 d	^{139}Ce	γ	137.65 d
^{56}Co	β^+,γ	77.3 d	^{141}Ce	β^-,γ	32.50 d
^{58}Co	β^+,γ	70.8 d	^{195}Au	γ	183 d
^{59}Fe	β^-,γ	44.6 d	^{203}Hg	β^-,γ	46.59 d
^{85}Sr	γ	64.85 d	^{230}Th	α	7.7×10^4 y
^{95}Zr	β^-,γ	65.5 d	^{232}Th	α	1.40×10^{10} y
^{95}Nb	β^-,γ	35.5 d	^{235}U	α	7.1×10^8 y
^{103}Ru-^{103m}Rh	β^-,γ	39.35 d	^{238}U	α	4.49×10^9 y

On occasion a few selected radionuclide solutions, not listed above, are calibrated. Letters will be sent to known requestors of low-level radionuclide solutions to efficiently allocate the distribution of these solutions.

A solution standard of radium-228, a beta emitter, is being prepared under contract for distribution by EPA. These calibrated radium-228 samples should be available for distribution to users in early 1977.

RADIOACTIVE GAS SAMPLES

Mixtures of radioactive gases in air are available for distribution. These samples are contained in refillable propane bottles similar to those supplied commercially for propane lamps, stoves, or gas torches. Currently only krypton-85 is available. Krypton-85, with a half-life of 10.72 years, emits both beta particles and gamma rays.

SOIL SAMPLES

Several soil samples have been prepared and analyzed under contract for distribution by EPA. These soil samples have been dried, ground to pass a 170-mesh or a 200-mesh screen, and carefully blended. Reports of calibration will accompany the samples. The samples will be packaged in plastic containers and will contain sufficient material to enable users to perform expected analytical methods in triplicate. Soils available are:

1. Standard Pitchblend Ore

   Principal radionuclides ^{238}U, ^{235}U

   Principal daughter products ^{210}Pb, ^{210}Po, ^{234}U, ^{230}Th, ^{231}Pa, ^{226}Ra, ^{227}Ac, ^{227}Th, ^{214}Pb

2. Diluted Pitchblend

   This is approximately a 10:1 dilution of material 1 with low-activity soil used for dilution.

3. Standard Monazite Ore

   Principal radionuclides analyzed - ^{232}Th, ^{230}Th, ^{228}Th, ^{228}Ra

4. Diluted Monazite Ore

   This is approximately a 10:1 dilution of material 3 with low-activity soil used as diluent.

5. Mill Tailings (1)

   Principal radionuclides analyzed - ^{230}Th, ^{226}Ra, ^{210}Pb

6. Mill Tailings (2)

A composite mixture from 16 different mills.

Principal radionuclides analyzed - ^{230}Th, ^{226}Ra, ^{210}Pb

7. Diluted Mill Tailings

A 7:1 dilution of Sample 6 with low-activity soil used as a diluent.

8. Mancos Shale

For delivery in early 1977. This sample will be certified for ^{226}Ra activity.

COMPOSITE MIXTURES

A low-level solution sample containing tritium, strontium-90-yttrium-90, cesium-134 and radium-226 is being prepared. The activity levels, when diluted to a 4-liter sample, will be approximately 50 times the nominal lower limit of detection as defined in the HASL Procedures Manual* at the 95 percent confidence level. These solutions are expected to be available for distribution in December 1976.

PARTICIPATION IN CALIBRATED SAMPLE DISTRIBUTION PROGRAM

Any Federal, State, local or private laboratory involved in, or concerned with, environmental radiation monitoring and surveillance may participate in the calibrated sample distribution program. To request samples, complete one of the request forms included in this publication and return it to:

U.S. Environmental Protection Agency
Environmental Monitoring and Support Laboratory
Quality Assurance Branch (MSQ)
P.O. Box 15027
Las Vegas, NV 89114

All requests for calibrated samples should be submitted at least 3 weeks in advance in order to ensure delivery on the date required. Should additional forms be required, they may be requested from the same address.

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* HASL Procedures Manual, HASL-300, Health and Safety Laboratory, ERDA, New York, New York. John H. Harley, ed. pp D-08-d,02,03. Rev. August 1974.

RADIONUCLIDE REQUEST FORM

TO: U.S. Environmental Protection Agency
Environmental Monitoring and Support Laboratory
Quality Assurance Branch
P.O. Box 15027
Las Vegas, NV 89114

Please ship the calibrated samples listed below to:

Contact Person _____

Title _____

Laboratory _____

Address _____

_____

Telephone _____

AEC License
and/or Type(s) _____

State License Number(s) _____

NOTE: If either by-products (in quantities greater than exempt quantities) or special nuclear materials are requested, a copy of the NRC license(s) should accompany the first request.

Radionuclide Samples Desired:

_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

I certify that the calibrated sample(s) requested are to be used only in this laboratory by qualified personnel for the purpose of developing or checking analytical procedures and/or for the calibration of instrumentation.

I further certify that I am authorized to receive the above listed radionuclides under the license number(s) listed above or that this laboratory is exempt from licensing regulations.

Date _____ Signature _____

Title _____